REMARKS

Claims 1-15 and 41-42 are now pending in this application for which applicant seeks reconsideration. Claims 7-13 remain withdrawn as directed to non-elected species.

Amendment

In light of the examiner's objection to the specification, paragraph 96 has been amended to incorporate the ranges recited in the claims. Since the claims are part of the original disclosure, no new matter is introduced by incorporating the ranges recited in the original claims into the detailed description.

Claims 1 and 3-15 have been amended to overcome the non-art objection/rejection, as well as to improve their form and readability. Also, superfluous language has been deleted from the claims. Independent claim 1 further has been amended to more clearly define the cutting part. Claim 1 also incorporates part of claim 6.

New claims 41 and 42 have been added to further define the present invention.

No new matter has been introduced.

Art Rejection

Claims 1-5 and 14-15 were rejected under 35 U.S.C. § 103(a) as unpatentable over Niman (USP 4,063,841) and claims 1-6 and 14-15 were rejected under § 103(a) as unpatentable over Hofmann (USP 5,031,491). Applicant traverses these rejections because these references fail to disclose or teach the configuration of the cutting part set forth in claim 1.

Claim 1 calls for a turning tool for cutting circumferential grooves into a surface of a polishing pad formed of a resin material for polishing semiconductor devices. The tool has at least one plate-like shaped tool tip and at least one cutting part extending from one side of the tool tip. The cutting part has a width within a range of 0.005-1.0mm, a wedge angle within a range of 15-35 degrees, and a front clearance angle within a range of 65-45 degrees, for cutting circumferential grooves into the surface of the resin polishing pad.

Niman and Hofmann each disclose a turning tool for cutting rigid works, such as metal, but do not disclose the claimed configuration of the cutting part. Applicant submits that there would not have been any motivation for Niman or Hofmann to configure the cutting tool as set forth in claim 1, particularly since Niman and Hofmann are not directed toward cutting circumferential grooves into the surface of the resin polishing pad. Indeed, Niman's and Hofmann's tools are not suitable for grooving a polishing pad made of deformable materials for the following reasons.

A polishing pad for polishing semiconductor devices must be capable of planarizing a semiconductor substrate at a very sophisticated level, i.e., at a level of 0.25μm or smaller. See paragraph 8 of the present specification. If the grooves formed into the surface of the polishing pad lack uniformity across the entire polishing surface of the polishing pad, the pressure distribution can vary, making it impossible to provide uniform polishing required for the semiconductor planarization. See paragraph 126 of the present specification. Also, a highly sophisticated grooving is needed to prevent generation of burrs or bumps on the polishing surface of the polishing pad.

Niman and Hofmann fail to teach forming sophisticated grooves on the resin polishing pad, i.e., do not have the claimed ranges of angles. For instance, when a circumferential groove with a diameter of 20mm is formed with a depth of 1mm into a surface of the resin polishing pad, by using a turning tool having a front clearance angle not within the claimed range, e.g., 10 degrees, the value of the turning tool interference against the outer circumferential portion of the groove amounts to 1.496mm according to the following equation:

$$\sqrt{(1 / \tan 10)\ 2} + 102 = 11.496$$

$$11.496\text{-}10 = 1.496.$$

On the other hand, when the same groove is formed using a turning tool having a front clearance angle within the claimed range, e.g., 60 degrees, the value of the turning tool interference against the outer circumferential portion of the groove amounts to merely 0.017mm. Appendix 1 (attached) for example shows one way of estimating the amount of turning tool interference. The claimed front clearance angle range makes it possible to effectively minimize the problem of the turning tool interference against the groove.

The turning tool interference against the groove creates undesirable groove width variations depending on the diameters of the grooves. The smaller the diameter of the groove, the greater the width of the groove caused by the turning tool interference against the groove. Since the polishing rate of the substrate is proportional to the abutting pressure of the polishing pad against the substrate, the groove width variation causes a pressure deviation, making it impossible to establish uniform polishing. By having the claimed configuration, it is possible to form the circumferential grooves into the resin polishing pad with a uniform groove width.

In addition, the turning tool needs a small or sharp wedge angle in order to form grooves into the resin polishing pad. Namely, if the wedge angle is larger than the claimed range, during feeding the turning tool into the surface of the polishing pad, thin cutting chips is less likely to be removed from the inside of the grooves, but is likely to stick to the grooves with excess compression of the pad, thereby breaking the surface of the polishing pad. Claim 1 defines the

wedge angle within a range of 15-35 degrees to prevent the pad compression during feeding of the turning tool, and allow the cutting chips to be removed from the grooves.

Referring to Figs. 4 and 5 of Niman and Figs. 2, 4, 6 and 8 of Hofmann, their turning tools have a very small clearance angle. On the other hand, as shown in Figs. 15B and 16B of the present specification, the claimed turning tool has a relatively large clearance angle within the range of 45-65°. This difference is important for cutting grooves onto the polishing pad, which has elasticity. The presence of a large clearance angle makes it possible to form grooves onto a resin polishing pad by cutting.

As shown in the attached Appendix 2 (attached), Explanatory View A, having a small clearance angle does not cause a frictional problem between the turning tool and the work surface of a hard material, such as metal, since it has no elasticity, and is not deformed by the pressure of the cutting edge. Therefore, a relatively small clearance angle would be desirable in the cutting edge to ensure durability in the turning tools of Niman and Hofmann.

In the case of the elastic material, such as the polishing pad, as shown in attached Explanatory View B, however, upon cutting grooves in the polishing pad, the polishing pad itself becomes deformed by the cutting edge pressure due to its elasticity. The small clearance angle of the turning tool causes a frictional problem between the cutting edge and the surface of the polishing pad. This can produce burrs or other defects in the walls of the grooves. Thus, the cutting tools of Niman and Hofmann can not cut grooves having a small-width and a small radius into the surface of the polishing pad. See paragraph 7 of the present specification.

Further, the present inventor found that the repeated friction between the cutting edge and the polishing pad creates a strong static electricity, causing cutting chip to undesirably stick to the cutting surface, causing more problems. It is therefore impossible for the conventional turning tools to cut grooves into a resin type polishing pad with dimensions required for polishing semiconductor devices needing a planarization in the micron order.

The present inventor found the abovementioned problems and invented a grooving tool with a novel configuration. As will be understood from attached Explanatory View C, a sufficient clearance angle within the claimed range of 45-65° is effective to avoid friction between the turning tool and the surface of the polishing pad, thereby eliminating the problems identified above, while making it possible to form fine circumferential grooves with a sufficiently small width and with a high dimensional accuracy.

Niman and Hofmann are completely silent about the problem created by the small clearance angle as stated above. In short, Niman and Hofmann would not have taught increasing the clearance angle. Applicant thus submits that there would not have been any

motivation for Niman or Hofmann to configure the cutting tool as set forth in claim 1.

Conclusion

Applicant submits that claims 1-15 and 41-42 patentably distinguish over the applied references and are in condition for allowance. Should the examiner have any issues concerning this reply or any other outstanding issues remaining in this application, applicant urges the examiner to contact the undersigned to expedite prosecution.

Respectfully submitted,

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14 AUGUST 2005
DATE

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